d. If a sound wave in air has displacement amplitude 0.02 mm then calculate the pressure amplitude for frequency 150 Hz.

$[B = 1.42 \times 10^5\ Nm^2, v = 344\ m/s]$ [Ans: $\mathbf{7.78\ Pa}$] [2]

e. Find the intensity of the sound wave in air whose maximum pressure variation is $3 \times 10^{-2} pa$, The density of air is $\rho = 1.20 kg/m^3$ and the speed of sound is $340 m/s$. [2]

2. a. What is intensity of sound? [1]

b. Show that intensity varies inversely proportional to the square of amplitude of sound. [3]

c. The ratio of intensities of two waves at a point is 25: 16. Calculate the ratio of amplitude of two waves. [2]

d. A sound has an intensity of $5 \times 10^{-7}\ Wm^{-2}$. What is decibel sound level? What is the bel level? [***57 dB; 5.7 bel***] [2]

e. At a point 20 m from a small source of sound, the intensity is 0.5 μWm^{-2}. Find a value for the rate of emission (power) from the source. ($\mathbf{0.25\ W}$) [2]

f. The volume level of an outdoor public address system is adjusted to 55 dB for people 5 m away. What will be its intensity level for people at distance 45 m? [$\mathbf{35.9\ dB}$] [2]

g. When a jet plane is flying on elevation of 1000m the sound level on the ground is 4.0 dB. What would be the intensity level on the ground when its elevation is as low as 100m? (**24 dB**) [2]

h. When a jet plane is flying at an elevation of 1000m, the sound level on the ground is 4 dB. What would be the intensity level on the ground when its elevation is as low as 50 m? [$\mathbf{30\ dB}$] [2]

3. a. Define doppler's effect. [1]

b. Write its applications and its limitations. [2]

c. Establish an expression of apparent frequency when both source and observer are moving along same direction. [2]

d. Whistle of an approaching train is shriller, why? Obtain an expression of apparent frequency heard by the observer in the given case. [3]

e. A source of sound generates sound waves which travel with a speed of 340 m/s. The frequency of source is 500 Hz. Find the frequency of sound heard if:

i. The source is moving towards the stationary observer at 30 m/s **[550 Hz]**

ii. The observer is moving towards the stationary source at 30 m/s **[545.45 Hz]**

iii. Both source and observer move at 30 m/s and approach one another. **[600 Hz]**

f. A car, sounding a horn with note 500 Hz, approaches and then passes a stationary observer at a steady speed of 20m/s. Calculate the change in frequency heard by the observer. [velocity of sound is 330 m/s] (**Ans: 59 Hz**) [3]

g. A car travelling with a speed of 60 Km/Hr. sounds a horn of frequency 500 Hz. The sound is heard in another car travelling behind the first car in the same direction with a speed of 80 Km/Hr. What frequencies will the driver of the second car hear before and after overtaking the first car? Velocity of sound is 340 m/s. [***507.8Hz; 491.4Hz***] [3]

Wave nature of light

1. Huygen's theory is applicable to explain the wave nature of light.

a. Write Huygen's principle. [1]

b. Verify the laws of reflection using Huygen's principle. [2]

c. Explain, in brief, how can you convert a spherical wave front into plane wave front.

d. Verify the laws of reflection using Huygen's principle. [2]

e. What is wavefront? How is spherical wavefront produced? [2]

f. What is wavelet. What is the speed of wavelets? [2]

g. Explain in brief, how is plane wavefront converted into spherical wavefront? [2]

Interference of Light

- Constructive interference occurs when two light waves superimpose in same phase.

  $[\boldsymbol{Phase\ difference = 0,\ 2\pi,\ 4\pi, 6\pi} \ldots\ldots$ $\{\boldsymbol{2n\pi\,; n = 0, 1, 2, \ldots}\}]$

  $[\boldsymbol{Path\ difference = 0,\ \lambda,\ 2\lambda, 3\lambda}, \ldots\ldots$ $\{\boldsymbol{n\lambda\,; n = 0, 1, 2, \ldots}\}]$

- Destructive interference occurs when two light waves superimpose in opposite phase.

  $[\boldsymbol{Phase\ difference = \pi,\ 3\pi, 5\pi}$ $\{\boldsymbol{(2n-1)\pi\,; n = 1, 2, \ldots}\}]$

  $[\boldsymbol{Path\ difference = \frac{\lambda}{2},\ 3\frac{\lambda}{2},\ 5\frac{\lambda}{2},\ 7\frac{\lambda}{2}}, \ldots\ldots$ $\{\boldsymbol{(2n-1)\frac{\lambda}{2}\,; n = 1, 2, \ldots}\}]$

- **For central maximum,** $\boldsymbol{path\ difference = 0}$ **and** $\boldsymbol{phase\ difference = 0.}$
  - Angular width of central maximum $= \boldsymbol{\frac{\lambda}{d} = \frac{\beta}{D}}$ (in radians) $[\boldsymbol{\pi^c = 180^o}]$
  - Linear width of central maximum $= \boldsymbol{\frac{\lambda D}{d} = \beta}$

Secondary maxima:

Linear position: $\boldsymbol{y_n = n\,\frac{\lambda D}{2d}}$

$\boldsymbol{\theta_n = n\frac{\lambda}{d}}$

Secondary minima:

Linear position: $\boldsymbol{y_n = (2n-1) \times \frac{\lambda D}{2d}}$

$\boldsymbol{\theta_n = (2n-1) \times \frac{\lambda}{2d}}$

$[\boldsymbol{n = 1, 2, 3, \ldots}]$

Fringe width, $\boldsymbol{\beta = \frac{\lambda D}{d}}$ [for both bright and dark fringes]

✓ When the whole apparatus is immersed in water, the width of central maxima decreases due to decrease in wavelength of light in water.

$$[\ \boldsymbol{\beta_{liquid} = \frac{\beta_{air}}{\mu_{liquid}}}\ ]$$

1. Interference is the redistribution of energy due to the superposition of two waves.

a. Write the suitable conditions for interference? [1]

b. In Young's slits experiment the separation of the first to fifth fringes is 2.5 mm when the wavelength used is 620 nm. The distance from the slits to the screen is 80 cm. Calculate the separation of two slits. [3]

c. A double-slit interference experiment is set up using coherent red light ($6500 nm$). The separation of the slits is 0.86m. The distance of the screen from the double slit is 2.4 m. A series of bright and dark fringes are observed on the screen. Estimate the separation of two consecutive bright fringes on the screen in an interference pattern due to double slit. [2]